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Prior regular exercise reverses the decreased effects of sleep deprivation on brain-derived neurotrophic factor levels in the hippocampus of ovariectomized female rats

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ABSTRACT

Previous studies indicated that brain-derived neurotrophic factor (BDNF) is the main candidate to mediate the beneficial effects of exercise on cognitive function in sleep deprived male rats. In addition, our previous findings demonstrate that female rats are more vulnerable to the deleterious effects of sleep deprivation on cognitive performance and synaptic plasticity.

Therefore, the current study was designed to investigate the effects of treadmill exercise and/or sleep deprivation (SD) on the levels of BDNF mRNA and protein in the hippocampus of female rats.

Intact and ovariectomized (OVX) female Wistar rats were used in the present experiment. The exercise protocol was four weeks treadmill running and sleep deprivation was accomplished using the multiple platform method. Quantitative reverse transcriptase-polymerase chain reaction (RT-PCR) and immunoblot analysis were used to evaluate the level of BDNF mRNA and protein in the rat hippocampus respectively.

Our results showed that protein and mRNA expression of BDNF was significantly ($p < 0.05$) decreased after 72 h SD in OVX rats in compared with other groups. Furthermore, sleep deprived OVX rats under exercise conditions had a significant ($p < 0.05$) up-regulation of the BDNF protein and mRNA in the hippocampus.

These findings suggest that regular exercise can exert a protective effect against hippocampus-related functions and impairments induced by sleep deprivation probably by inducing BDNF expression.

1. Introduction

Human and animal studies suggest that sleep has an important role in certain types of learning and memory and neuronal plasticity [1]. Accordingly, sleep deprivation causes memory deficit and decreases hippocampal level of BDNF [2,3]. In addition, BDNF is present in high concentration in the hippocampus and cerebral cortex and is very important for learning and memory [4].

Sleep disorders are almost frequent in modern society particularly in menopausal women. In menopausal women, sleep disturbances may be the most important indications for hormone therapy and certainly necessitate to be used as specific treatment in this group [5,6]. Additionally, despite the beneficial effects of estrogen on the brain functions, hormone replacement therapy increased adverse cardiovascular and oncological effects [7]; there is noticeable attention in developing healthier therapeutic approaches to alleviate sleep deprivation-associated impairments.

It has been indicated that exercise is one of the most potent non-pharmacological interference that can improve the cognitive functions around the postmenopausal period [8].

It has been demonstrated that exercise can alter some neurotransmitters and neurotrophin expression [4]. Altered expression of neurotrophic factors, for example BDNF is recognized to play a vital role in the hippocampus-related functions, synaptic plasticity [9,10] and psychiatric disorder [11]. Furthermore, it has been indicated that regular exercise can modulate the induction of mRNA and protein of BDNF within the hippocampus which may contribute to the maintenance of brain health and synaptic plasticity [4,12,13].

Several lines of evidence indicate that BDNF is a potential mediator of the central effects of estrogen. In particular, there are the extensive similarities between the functions of estrogen and BDNF in the CNS [14]. BDNF also provides both neurotrophic and neuroprotective support to different subpopulations of neurons, and is mostly associated

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